

# Water bridge experiment from TGD point of view

M. Pitkänen  
Email: [matpitka6@gmail.com](mailto:matpitka6@gmail.com).  
<http://tgdtheory.com/>.

June 23, 2020

## Abstract

The formation of a rather stable water bridge between two beakers containing purified water and having voltage 15-25 kV providing them with opposite charges is in conflict with intuitive views about water as liquid. TGD inspired model for water bridging phenomenon allows an excellent opportunity to summarize some aspects of the basic vision behind TGD inspired quantum biology and shows that this strange phenomenon provides evidence for the proposal that quantum biology is much more than quantum chemistry.

Even more: prebiotic quantum biology of water could be quantum biology without biochemistry, and the basic mathematics behind evolution and behind basic scales of biology could reduce to number theory. Even genetic code realized at the level of dark matter could have been present in pre-biology and that biochemistry would serve as a slave and dark matter at the magnetic body (MB) is the master.

## Contents

<b>1</b>	<b>Introduction</b>	<b>1</b>
<b>2</b>	<b>General vision about quantum biology in TGD Universe</b>	<b>2</b>
2.1	Number theoretical vision . . . . .	2
2.1.1	Evolutionary hierarchy as hierarchy of extensions fo rationals . . . . .	3
2.1.2	p-Adic and adelic physics . . . . .	3
2.2	Biological vision . . . . .	4
2.2.1	Hierarchy of Planck constants defines quantal master-slave hierarchy . . . . .	4
2.2.2	Dark matter at magnetic flux tubes as master . . . . .	4
2.2.3	Energy and frequency resonance as basic interaction mechanism between phases of matter labelled by $h_{eff} = nh_0$ . . . . .	5
2.2.4	Pre-biology as quantum biology of water . . . . .	6
<b>3</b>	<b>TGD inspired model of water bridge</b>	<b>6</b>
3.1	Some facts about water bridge experiment . . . . .	6
3.2	A simple model for the water bridge . . . . .	7
3.2.1	Model for EZ as a ball bounded by analog of cell-membrane . . . . .	8
3.2.2	The condition that the reduction of the electrostatic is not smaller than the increase of the gravitational energy . . . . .	9
3.2.3	The flows associated with the water bridge . . . . .	10
3.2.4	How could one test experimentally the hypothesis about water Planckeons? . . . . .	11

## 1 Introduction

The formation of a rather stable water bridge between two beakers containing purified water and having voltage 15-25 kV providing them with opposite charges is in conflict with intuitive views about water as liquid. TGD inspired model for water bridging phenomenon allows an excellent opportunity to summarize some aspects of the basic vision behind TGD inspired quantum biology

and shows that this strange phenomenon provides evidence for the proposal that quantum biology is much more than quantum chemistry.

Even more: prebiotic quantum biology of water could be quantum biology without biochemistry, and the basic mathematics behind evolution and basic scales of biology could reduce to number theory [L6, L7]. Even genetic code realized at the level of dark matter [L4, L1] could have been present even at the level of water and that biochemistry would serve as a slave and dark matter at the magnetic body (MB) is the master.

The model relies on simple observations about the water bridge.

1. The stability of the water bridge requires coherence making water analogous to gel. Self-organization involves a generation of coherence. TGD based view about self-organization is quantal: the long range quantum coherence of dark matter identified as phases of ordinary matter labelled by the value of effective Planck constant  $h_{eff} = nh_0$  [L6, L7] would induce self-organization as a coherence of ordinary matter.

In the number theoretic vision about TGD  $n$  is identified as dimension of extension of rationals and measures algebraic complexity and therefore also the evolutionary level. Dark matter has higher "IQ" equal to  $n$  and for it quantum scales are longer. Therefore it serves as a "boss" for the lower levels of the hierarchy, in particular ordinary matter. The water bridge is excellent candidate for a macroscopic quantum system controlled by MB.

2. The negatively charged exclusion zones (EZs) discovered by Pollack can be explained in TGD as being produced as part of protons inside EZ transforms to dark protons at magnetic flux tubes in the complement of EZ - CEZ. The guess is that the water bridge between positively and negatively charged beakers consists of negatively charged EZs and positively charged CEZs, where the flux tubes carrying dark protons reside. The flux tubes would give the system its gel like structure and Coulomb attraction between EZs and CEZs would guarantee its stability. Note that Inside EZ:s water forms also layered structures consisting of 2-D hexagonal lattices rather than being liquid-like [L3] [L3].
3. EZs (CEZs) would serve as dynamical units and arrive to the bridge from negatively (positively) charged beaker due to the presence of attractive Coulomb force caused by the electric field. The electric force must be stronger than gravitational force: hence the electric field must be overcritical. The condition gives a lower bound for the size scale of EZ. Surprisingly, in the model for EZ as ball, the maximal radius of EZ is very precisely equal to the radius of a water ball having Planck mass and equals to the size of large neuron.

## 2 General vision about quantum biology in TGD Universe

Geometry [K2] and number theory [K3] are key threads of quantum TGD. Water bridge phenomenon could be an example of quantum biology without bio-chemistry involving two key elements of TGD.

1. The new view about space-time and fields involves the notions many-sheeted space-time and magnetic body (MB).
2. TGD view about quantum self-organization based on number theoretic vision involving hierarchy of extensions of rationals, p-adic physics for various primes  $p$  as correlates of cognition, and their fusion with reals to a hierarchy of adelic physics. This hierarchy corresponds to evolutionary hierarchy.

First a brief summary about this vision is discussed. The philosophical aspects of TGD inspired view about quantum biology and consciousness are discussed in [L12, L2].

### 2.1 Number theoretical vision

Number theory entered to TGD via p-adic mass calculations around 1993 but it soon turned out that p-adic numbers fields are natural correlates for cognition. This eventually led to a vision that I call adelic physics [L6, L7]. All number fields play a key role in this vision. Number theoretic

vision involves also classical number fields (reals, quaternions, octonions) and the notion of infinite primes but since these aspects are not needed in the model of water bridges, they will not be discussed here.

### 2.1.1 Evolutionary hierarchy as hierarchy of extensions fo rationals

The extensions are induced by the roots of irreducible polynomials  $P(x)$  having integer coefficients (not reducing products of lower-degree polynomials). The roots are algebraic numbers. The dimension of extension is equal to the degree  $n$  of the polynomial. Extensions of rationals in turn induce extensions of p-adic number fields.

The extensions of rationals would be behind evolutionary hierarchies. Evolution would be emergence of extensions of rationals with increasing dimension  $n$  serving as a measure of algebraic complexity and defining a kind of "IQ". Evolution is un-avoidable since the number of extensions with dimension smaller than  $n$  is finite and those larger than  $n$  infinite.

Extensions of extensions of extensions of .... with dimensions coming as  $n_1|n_2|n_3, \dots$ , where  $|$  is for "divides". Evolutionary step would correspond to a the appearance of a new level in the hierarchy of extensions. One forms in this step polynomial  $P_n(P_m(x))$  with  $P_n(0) = P_m(0) = 0$  having degree  $n \times m$ . Extensions in this kind of hierarchy are analogous to conserved genes in biology. There is also analogy with abstraction process: functions of functions of.... or statements about statements about..... These hierarchies play key role in TGD.

### 2.1.2 p-Adic and adelic physics

p-Adic/adelic physics is part of the number theoretical vision [K8]. Preferred p-adic primes near powers of 2 are characteristic for this vision.

1. The proposal is that preferred p-adic primes labelling p-adic number fields are so called ramified primes  $p_R$  of extension of an extension of rationals inducing also extensions of rationals.

Ramified primes [L18] appear as prime factors of the discriminant  $D$  of polynomial, which is product over the differences of its roots and can be calculate once the irreducible polynomial with rational or equivalently integer coefficients determining the extension is known. For second order polynomial  $P(x) = ax^2 + bx + c$  one has  $D = b^2 - 4ac$ .

2. Ramified primes have the special property that their expression as a product of primes of extension involves less than  $n$  primes of extension: some primes of the extension appear as powers higher than 1 and the sum of orders for powers is  $n$ .

Furthermore, in the  $O(p) = 0$  approximation for p-adic integers (p-adic integers replaced with finite field  $F_p$ ) the polynomials has multiple roots which has interpretation as quantum criticality in p-adic sector: they would be thus cognitively special. Quantum criticality is indeed fundamental aspect of TGD physics: criticality condition fixes the values of various couplings parameters so that quantum criticality would fix the physics completely and make it maximally rich. In catastrophe theory of Thom criticality is in a central role and TGD involves the analog of catastrophe theory.

There are also primes, which do not split at all in the extension and those which split maximally to  $n$  factors. The numbers of both are infinite.

The number of ramified primes characterizing the extension is always finite. Ramified primes are identified as physically preferred p-adic primes. For hierarchies of extensions of extensions of.... ramified primes defined by polynomials vanishing at origin are analogous to conserved genes.

3. p-Adic mass calculations [K7] demonstrated that elementary particles, and also hadrons are characterized by preferred/ramified primes near to power of 2. I call this conjecture p-adic length scale hypothesis. It generalizes also to primes 3 and 5 and maybe also to other small primes.

Why primes near powers of 2? The argument is that in periodic doubling powers of 2 appear. Powers of 2 multiplying  $CP_2$  scale define a fractal hierarchy of scales in 2-adic physics, which

represents the lowest level of cognition. Small deformation of power of  $2^m$  (in real sense) to prime  $p = 2^m \rightarrow 2^m - k$  gives rise to p-adic primes near powers of 2. Mersenne primes  $M_n = 2^n - 1$  are optimal in this sense and label charged leptons and hadrons.

Polynomials giving rise to the extensions are realized quite concretely.  $M^8 - H$  duality [L5, L15, L16], where one has  $H = M^4 \times CP_2$ , states that one can equivalently regard space-times as 4-D surfaces in either  $H$  or 8-D Minkowski space  $M^8$ , which is complexified and has interpretation as complexified octonions. In  $M^8$  space-time surfaces would be 4-surfaces, which have associative (quaternionic) tangent or normal space and would be defined as roots for real or imaginary part of an octonionic polynomial determined as an algebraic continuation of a real polynomial with integer coefficients giving rise to the extension of rationals. These surfaces would define the evolutionary hierarchy and be mapped to surfaces in  $H$  by  $M^8 - H$  duality.

## 2.2 Biological vision

In the following only those aspects of the vision about quantum biology relevant for the water bridge phenomenon are discussed. In particular, zero energy ontology (ZEO) crucial for quantum biology and quantum consciousness in TGD Universe, is not discussed. The interested reader can consult [L8, L12] [K4]. The latest experimental findings of Mineev et al [L14] demonstrating that state function reduction does not look what it is expected to look provides strong support for ZEO [L14].

### 2.2.1 Hierarchy of Planck constants defines quantal master-slave hierarchy

Physically the degree/dimension  $n$  would correspond to effective Planck constant  $n = h_{eff}/h_0$  would label dark matter identified as phases of ordinary particles with Compton lengths scaling like  $h_{eff} \propto n$  so that for large values  $n$  macroscopic quantum coherence would be obtained.

The hierarchy  $n_1|n_2|n_3\dots$  would form master slave hierarchy [L17] (see <http://tinyurl.com/y3xbkokb>). The level  $n_{i+1}$  would serve as a boss for the level  $n_i$ . This would be true at least in quantum biology but perhaps quite generally in self-organizing systems. The control by dark matter would force coherence at lower levels, in particular for ordinary matter. This would dramatically modify the existing views about classical physics as "classical".

Note however that classical physics is an exact part of quantum TGD in the sense that in ZEO zero energy states are superpositions of deterministic time evolutions analogous to Bohr orbits connecting states at the boundaries of causal diamond CD ( $cd = CP_2$ , where  $cd$  is causal diamond of  $M^4$ ). The interpretation as quantum variant of behavior, function, or of computer program is natural. Act of free will as quantum jump would replace this deterministic quantum program with a new one.

Since the energy of system as function of  $h_{eff}$  increases with  $h_{eff}$  when other parameters are kept constant, the increase of  $h_{eff}$  requires energy. Furthermore,  $h_{eff}$  tends to decrease spontaneously since there exist lower energy states. Energy feed is required to keep the situation steady. This energy feed is interpreted as metabolic energy feed in biology and this interpretation is attractive also in general self-organization known to require energy feed. Non-equilibrium thermodynamics would be replaced with quantum theory based on dark matter in TGD sense and quantum physics of dark matter would be visible everywhere were long range correlations are present if this picture is correct [L17].

### 2.2.2 Dark matter at magnetic flux tubes as master

Dark matter would reside at magnetic flux tubes and sheets forming the body parts of MB,

1. In Pollack effect [L3] [L3] dark nuclei as sequences of dark protons with non-standard  $h_{eff}/h_0 = n$  would be formed as protons go to the flux tubes creating EZs with electronic charge and 4th phase of water. Metabolic energy needed to increase  $n$  would come from the energy feed - say infrared light in the case of Pollack effect.
2. Quantum biology without chemistry would involve also dark realization of genetic code and analogs of DNA, RNA, tRNA, amino-acids as sequences of dark proton triplets [L4, L9]. The

proposal for the dark genetic code is consistent with vertebrate genetic code in the sense that the numbers of DNA codons coding for a given amino-acid are same. One could say that ordinary bio-chemistry is mimicry of dark biology. For instance, dark DNA would accompany ordinary DNA. The negative charges of DNA/RNA nucleotides would be compensated by the positive charges of protons and this would stabilize DNA and RNA.

That information theoretic level of biology would be represented at the level of dark matter is number theoretically very natural since extensions of rationals define a candidate for an evolutionary hierarchy, cognition has p-adic correlates, and p-adic variants of Shannon entropy provide a definition of entanglement negentropy as a measure of conscious information. Ordinary biological realization would rely on the mimicry of the code at the level of biochemistry. This mimicry would not be complete: for instance, there are several variants of chemical genetic code.

3. There is also a realization of genetic code in terms of dark photon triplets analogous to 3-chords defining what I call bio-harmony [L1]. The resonant interaction via dark photon triplets - 3-chords of music of light - makes possible communications and control as analogs of radiowave communications. Genetic code realized in terms of 3-chords would allow only similar codons to be in contact. Also now the numbers of DNA codons coding for given amino-acid are predicted correctly. Bio-harmonies would be fusions of 3 icosahedral harmonies for which 12-note scale is represented as a Hamiltonian cycle of icosahedron and of tetrahedral harmony represented analogously.

There is large number of bio-harmonies and they would correlate with emotions/moods appearing already at molecular level [L10, L11]. Music indeed expresses and creates emotions having interpretation as holistic aspects of intelligence (emotional intelligence) whereas the interpretation of codon as 6-bits would correspond to the usual cognitive intelligence.

4. Gaussian Mersennes  $M_{G,n} = (1 + i)^n - 1$  associated with complex rationals- extension of rationals - are especially interesting biologically. In the length scale range between 10 nm (neuron membrane thickness and thickness of DNA primary coil for instance) and  $2.5 \mu\text{m}$  (size of the cell nucleus) there are 4 p-adic length scales assigned with Gaussian Mersennes. They correspond to  $n = 151, 157, 163, 167$ . So large number of Gaussian Mersennes in so short length scale interval is a number theoretical miracle and one expects that these scales appear already in prebiotic physics as fundamental physical scales. These scales could be associated with DNA coiling, DNA super-coilings, and cell nucleus itself.

### 2.2.3 Energy and frequency resonance as basic interaction mechanism between phases of matter labelled by $h_{eff} = nh_0$

Only particles with same  $h_{eff}$  are assumed to interact in vertices involving more than 2 particles: this is interpreted as a synonym for darkness. The transformations changing the value of  $h_{eff}$  for single particle state are however assumed to be possible. The basic mechanism of control and communications would be resonance allowing selection of the receivers. One can speak of energy and frequency resonance, and for communications between phases with different values of  $h_{eff}$  one can say that either energy or frequency resonance is in question.

1. The basic interaction mechanism between phases with the same value of  $h_{eff}$  would be based on resonance much like in the case of radio-communications. This would select the receiver. The utilization of flux tubes as analogs of wave guides would make possible targeted communications. By  $E = h_{eff}f$  both energy and frequency resonance would be involved.

The interactions between phases with different value of  $h_{eff} = nh_0$  corresponding to  $n = n_1$  and  $n = n_2$  would involve a energy preserving transformation of  $n_1 \rightarrow n_2$  or its reversal but frequency would change. One could speak of energy resonance. For  $h_{eff,2} = h$  (there is evidence for  $h = 6h_0$ ) one would have a transformation of dark photon to bio-photon.

2. Also the decay of dark photons with  $n_1$  and  $E = n_1h_0f$  to  $n_1/n_2$  photons with  $E = n_2h_0f$  is possible if one allows vertices  $1 \rightarrow n$  vertices for  $n > 1$ . In particular, dark EEG photons with large  $n_1$  could decay to a bunch of  $n_1/n_0$  ordinary photons, where  $h = n_0h_0$  is true. In this case one could speak about frequency resonance.

3. Bio-photons have energies in UV and visible range and this requires rather large values of  $h_{eff}$  in the case of dark EEG photos [K5, K6]. Nottale [E1] introduced the notion of gravitational Planck constant  $\hbar_{gr} = \hbar_{eff} = GMm/v_0$ , where  $G$  is gravitational constant,  $M$  is larger mass (say solar mass of Earth's mass),  $m$  is small mass, and  $v_0 < c$  is velocity parameter. By Equivalence Principle the radii of Bohr orbits do not depend on  $m$  so that  $m$  can be taken to be even elementary particle mass. Cyclotron energies  $E_c = \hbar_{gr}eB/m$  are independent of the mass  $m$  of the charged particle in this case. MB could control bio-matter by inducing molecular transitions by energy resonance mechanism producing bio-photons and any charged particle could induce given transition of biomolecule. Magnetic field strength controlled by the thickness of the flux tube would serve as a control variable allowing tuning.

#### 2.2.4 Pre-biology as quantum biology of water

This picture suggests that the notion of quantum pre-biology as quantum biology of water could make sense. The water bridge phenomenon gives support for this vision.

1. Biochemistry would be absent and simplify the situation enormously. One could imagine study of the fundamental biology as study of water in the phase analogous to that of water bridge.
2. The biological scale hierarchy including Gaussian Mersennes and ordinary Mersennes plus other possible length scales would be however present. Already the structure and dynamics of water would involve basic biological structures and dynamics.
3. Sequences of dark proton triplets representing genetic codons and forming dark nuclei providing a representation of basic biomolecules would be present at flux tubes generated by Pollack effect. Also a representation of genetic code would be realized [L4]. Bio-harmony [L1] would provide a realization of the genetic code at the level of communications by resonance mechanism.
4. Macroscopic quantum phases, communications to MB and control by MB would be also present. Water, in particular the hydrogen bonded network, would serve as slave. Long flux tubes connecting EZs perhaps having an interpretation as very long hydrogen bonds (the length is proportional to  $h_{eff}$ ) would be central [L13] and make water analogous to gel phase. The water bridge experiment would represent an example of quantum pre-biology.

## 3 TGD inspired model of water bridge

After these preliminaries one can consider a TGD inspired model for the water bridge.

### 3.1 Some facts about water bridge experiment

The Wikipedia article about water thread experiment (see <http://tinyurl.com/y22vy26d>) gives details about the experiment.

1. Water beakers are positively and negatively charged. The water creeps from the first beaker and connects it to the second. The bridge is stable and lasts even 45 minutes.
2. The voltage  $V = 15 - 25$  keV between the water beakers generates opposite charges in the beakers. The length of the bridge varies up to 25 mm and its length increases with  $V$ . Critical electric potential corresponds to Coulomb energy  $E_c = eV = .01$  eV over distance  $d = 10$  nm of cell membrane thickness, which is roughly by factor of 1/7 weaker than the corresponding energy over cell membrane.

The first (wrong) guess concerning the interpretation for the water bridge would be that beakers are analogous to cell interior and exterior and bridge serves as an analog of generalized Josephson junction connecting cell interior and exterior in TGD based model of cell membrane.

- (a) Generalized Josephson junctions appear in the TGD based model for cell membrane and nerve pulse [K1]. Protein channels and pumps are identified as generalized Josephson junctions associated with flux tubes and generalization Josephson energies are sums of magnetic part and ordinary Josephson energy of  $E_J = .05 - .07$  eV so that the variation of  $E_J$  gives rise to frequency modulation so that Josephson radiation would resemble whale's song (or slowed down human speech). The nominal value for the resting energy with nominal value  $E \simeq .077$  eV for cell membrane is at the border of the thermal threshold: bio-system is minimizing the use of metabolic energy.

This energy is varying - in particular, during nerve pulses - and would mean a variation of generalized Josephson frequency of Josephson radiation assumed to code nerve pulse patterns to the dark Josephson radiation communicated to the MB of the system. The frequency range of radiation  $f_J = E_J/h_{eff}$  depends on  $h_{eff}$  and even EEG frequencies are possible for neurons.

- (b) Now the Josephson energies would be in the range 15 – 25 keV, which is quite too large to make sense as molecular energy. The flux tube is also too long and the assumption would require that the beakers are quantum systems analogous to superconductors. One cannot however exclude the possibility that the presence of cell membrane like structures in water could give rise to generalized Josephson junctions and communications of sensory data to MB.

The article of Namin and Lindi [D2] (see <http://tinyurl.com/y4zfoubj>) summarizes various models trying to explain the properties of the water bridge. The thesis [D1] of Adam Wexler gives a thorough treatment of the topic.

### 3.2 A simple model for the water bridge

The really interesting part of the system seems to be the water bridge behaving in totally unexpected manner. One must explain why it is formed - gravitational force opposes its formation - and why it is stable and behave somewhat like gel phase rather than liquid.

1. One can argue that total charge separation is impossible. The work must be done to give the beakers opposite charges. The attraction between positive and negative charges however implies that a bridge between beakers is formed and positive and negative charges from the beakers could flow to the bridge.

This Coulomb attraction is opposed by the gravitational field of Earth, and one must have some critical electric field  $E$  to overcome the gravitational force. The decrease of the attractive electrostatic energy must be larger than the increase of gravitational potential energy. Or equivalently, the gravitational force is not larger than electric force. This would explain why the phenomenon occurs only above critical electric field.

2. Assume that EZs serve as the basic dynamical units and that these units can climb in the gravitational field to the bridge. For modelling purposes assume that EZ is a ball with radius  $R$ , charge  $Q(R)$ , and mass  $M(R)$  determined by the density of water. Assume also that EZ has surface analogous to cell membrane with same thickness and same resting potential as ordinary cell. Assume that CEZ as a volume containing dark proton flux tubes is ball with the same radius so that gravitational forces and electric forces to EZ and CEZ have same magnitude.
3. A bridge as a Pollack phase would be formed containing EZs and positively charged regions containing flux tubes connecting the EZs and giving rise to the stability of the bridge. Gel like phase would be in question. Also in quantum biology this mechanism would be behind the phenomena such as formation of gel phases, ordered water, and 4th phase of water discovered by Pollack. The contents of hen egg is a good example of gel phase - maybe the same experiment could be carried out by using the contents of hen egg.

The Coulomb interactions between EZs and CEZs and also the energy of magnetic flux tubes would contribute to a tension stabilizing the bridge. In standard physics based models for the stability and properties of the bridge - such as the curvature of the bridge modelled as a

parabola - assume either that electric tension or surface tension is responsible for the stability. The predictions tend to give too large value for the parameter  $k$  defining the curvature of the parabola  $y = kx^2/2$  at origin as Fig. 4 of the article of Namin and Lindi [D2] (see <http://tinyurl.com/y4zfoubj>) demonstrates.

### 3.2.1 Model for EZ as a ball bounded by analog of cell-membrane

Consider first a simple model for EZ as a ball bounded by a pre-cell membrane having same thickness  $L(151) \simeq 10^{-8}$  meters as ordinary cell membrane. This would follow from p-adic length scale hypothesis implying the universality of basic biological length scales as fundamental physical length scales.

**Remark:** In the sequel natural units of particle physics with  $c = 1, \hbar = 1, k_B = 1$  will be used. In these units length and time corresponds to inverse energy and one has  $1/\text{mm} \leftrightarrow 1.24 \times 10^{-6}$  eV. Temperature is also measured in eVs.

1. Assume that the EZ as a ball of radius  $R$  is boundary by an analog of cell membrane realized already at the level of water (p-adic length scale hypothesis) as a layer of thickness of  $d \simeq 10^{-8}$  m. There is some negative net charge  $Q(R)$  inside the ball. Assume that that the resting potential (energy) is membrane potential (energy) is same as for ordinary cell and about  $E = .077$  eV. Since the potential behaves like

$$eV(R) = \frac{eQ}{R} \quad (3.1)$$

at the membrane, one has

$$V_{rest} = eV(R+d) - eV(R) = \frac{eQ(R)}{R^2} \times d . \quad (3.2)$$

One has

$$eQ(R) = eV_{rest} \frac{R^2}{d} = eV_{rest} R_0 \times \frac{R_0}{d} \times \left(\frac{R}{R_0}\right)^2 . \quad (3.3)$$

Using  $d = 10^{-8}$  meters and taking  $R_0 = 10^{-6}$  meters as reference scale one as  $(R_0/d) \simeq 10^2$ . Using  $eV_{rest} = .077$  eV one has using  $e$  as a unit of charge one has

$$Q(R) \simeq 7.7 \times \left(\frac{R}{R_0}\right)^2 . \quad (3.4)$$

The charge scales like  $R^2$  if the resting potential does not depend on  $R$ .

2. The mass of the EZ ball with radius  $R$  is given by

$$M(R) = M(R_0) \left(\frac{R}{R_0}\right)^3 , \quad M(R_0) = \frac{4\pi}{3} \times \rho_w R_0^3 . \quad (3.5)$$

For water density  $\rho_w \simeq 10^3 \text{ kg/m}^3$  and  $R = R_0$  one has

$$M(R_0) = \frac{4\pi}{3} \times 10^{-15} \text{ kg} \simeq \frac{4\pi}{3} \times .6 \times 10^{12} m_p \simeq \frac{4\pi}{3} \times 10^{21} \text{ eV} ,$$

where  $m_p$  is proton mass  $m_p \simeq 1.67 \times 10^{-27} \text{ kg} \simeq 10^9 \text{ eV}$ .

3. One can express the electric field  $eE = 10^3 \text{ eV/mm}$  in natural units of particle physicist as  $eE = .8 \text{ eV}^2$ .



### 3.2.2 The condition that the reduction of the electrostatic is not smaller than the increase of the gravitational energy

Consider next the condition that the reduction of electrostatic energy is larger than increase of the gravitational energy as EZ or its complement with the same size is raised to height  $h$  or offer  $h = 10$  mm. As a matter of fact,  $h$  disappears from the conditions since both gravitational and electric fields are constant.

1. Estimate first the change of the electrostatic energy as EZ ball of radius  $R$  as it is raised to height  $h$ . The reduction of the electrostatic energy is given by

$$E_{em} = Q(R)e\Delta V = Q(R)eEh = Q(R_0)\left(\frac{R}{R_0}\right)^2 eEh \propto R^2 . \quad (3.6)$$

2. The increase of the gravitational energy as EZ ball is raised to height  $h$  is given by

$$E_{gr} = M(R)gh = M(R_0) \times gh \times \left(\frac{R}{R_0}\right)^3 \propto R^3 , \quad M(R_0) = \left(\frac{4\pi}{3}\right)\rho_w R_0^3 . \quad (3.7)$$

3. Height  $h$  disappears from the condition  $E_{gr} \leq E_{em}$  so that the condition states that em force is not smaller than gravitational force. This gives an upper bound on the radius  $R$  of EZ. The same condition applies also to the complement of EZ.

$$\frac{R}{R_0} \leq \frac{Q(R_0)eE}{M(R_0)g} . \quad (3.8)$$

4. Using  $Q(R_0) = 7.7$ ,  $eE = .8$  eV<sup>2</sup>,  $M(R_0) \simeq (4\pi/3) \times 10^{21}$  eV and  $g = 10$  m/s<sup>2</sup>  $\simeq .9 \times 10^{-12}$  eV gives  $R \leq 168.0 \times R_0 \simeq 1.68 \times 10^{-4}$  m. This corresponds to the size scale of a large neuron. The charge within the volume defined by  $R$  would be about  $Q \simeq 2.73 \times 10^5 e$ .
5. Interestingly, a water volume having Planck mass  $M_{Pl} = 1.220910 \times 10^{19}$  eV = 2.176435(24)  $\times 10^{-8}$  kg corresponds to  $R_P = 1.74 \times 10^{-4}$  m, which is only 3.4 per cent larger than  $R$ .

One has  $R \simeq 69.6 \times L(167)$ , which is 2.3 per cent larger than p-adic length scale  $L(175)$ . The replacement of  $R$  with  $R_P$  is in error limits and reduces the error to 1 per cent. Could EZs really have Planck mass?

This looks surprising since the argument leading to the prediction involves only gravitational acceleration  $g$  at the Earth's surface, the assumption that EZ is bounded by a cell membrane like structure characterized by the nominal value of the resting potential, and the value of the critical electric field. Could the interpretation be that the critical value of electric field signals that cell membrane like structures are present in purified water and that EZs have Planck mass? Planck mass would emerge in biological length scales whereas  $CP_2$  mass which is by a factor about  $10^{-4}$  smaller would appear in elementary particle length scales [K7].

A couple of remarks about the model are in order.

1. The assumption that EZ:s and their complements with positive charge are spherical is a simplifying technical assumption: in a more general model they would have a more general shape. Gravitational potential is proportional to the volume if the size of the EZ is small as compared to the characteristic scale of  $h \sim 10$ one mm as it indeed would be with accuracy of per cent. Electric potential energy in turn is expected to be proportional the area of EZ in good approximation. Hence the volume of water in EZ is expected to be near Planck volume.
2. Also EZs with radius smaller than  $R \simeq R_P$  are allowed. Can one deduce a lower bound for  $R$ ? Nottale's proposal for  $h_{gr}$  [E1] indeed allows this. Suppose the magnetic flux tubes carrying dark protons mediate gravitational interaction and have  $h_{eff} = h_{gr} = GMm/v_0$

( $v_0/c < 1$ ). The condition  $h_{eff} > h$  poses a condition to the product of masses in terms of Planck mass:  $Mm > (v_0/c) \times m_{Pl}^2$ . If this is true,  $M = m$  gives the lower bound

$$M \geq \sqrt{v_0/c} \times m_{Pl} \quad (3.9)$$

for the mass of EZ. This could explain also the appearance of smaller basic structures but provide a lower bound for their mass. A rough estimate for  $v_0/c$  is order order  $2^{-11}$  in the model for planetary orbits in solar system. The lower bound for  $R$  would be  $(v_0/c)^{1/6} R_{Pl} \sim 48 \mu\text{m}$ .

What about structures with smaller size, say cell nuclei of size scale  $2.5 \mu\text{m}$  and mass  $m \sim 10^{-6} m_{Pl}$ ? For them the condition  $Gm^2/v_0 \geq 1$  (gravitational flux tubes would connect two cell nuclei) would give  $v_0/c \sim 10^{-12}$ . One could also consider the possibility that the structure with small mass  $m$  is paired with larger mass  $M$  so that the condition would read  $m \geq (v_0/c) M_{Pl}^2/M$ . The problems posed by small structures would be solved by the presence of large mass, such as the mass of Earth.

Mass  $M$  could be identified as the total mass of CEZs meaning if the flux tube network itself does not decompose to pieces, one for each CEZ. The order of magnitude for this mass would be one half of the total mass of the water bridge, whose volume is of order  $L^3 \sim cm^3$ . This would give  $M \sim L^3/R_{Pl}^3 M_{Pl} \sim 106 M_{Pl}$  and  $h_{gr} \sim 10^6 (c/v_0)$ .

**Remark:** The estimate giving Planck mass as upper bound was based on the requirement that the gravitational force is compensated by the electric force so that the application of the result forgetting the context might be dangerous. The lower bound is however general.

3. What about non-spherical structures like DNA and axonal membranes and cell membranes assuming that Planck mass defines an upper bound for the mass. One can consider also non-spherical geometries using Planck mass as upper bound for the mass of these structures. Now one must use the actual mass of the structure, which need not consist of water.
  - (a) Cell and axonal membranes have local planar sheet geometry and this allows smaller size scale as transversal scale. Assume that this kind of structure has density  $\rho$ . For instance, for spherical cell membrane with  $V = 4\pi R^2 d$ , with  $d \simeq 10 \text{ nm}$  satisfying  $\rho V \leq \rho_W V_{Pl} = (4\pi/3) \times R_{Pl}^3$ , one obtains  $R \leq (\rho_W/\rho)^{1/2} \times (R_{Pl}/3d)^{1/2} R_{Pl} \simeq (\rho_W/\rho)^{1/2} \times 1.3 \text{ cm}$ .
  - (b) For linear cylindrical structure such as axonal membrane having radius  $R_a \simeq 10^{-6}$ , thickness  $d \simeq 10 \text{ nm}$ , and length  $h$ , one obtains  $V = 2\pi R d h$  giving  $h \leq (\rho_W/\rho) \times 52 \text{ m}$ . For micro-tubular cylindrical surfaces with  $d \simeq 10 \text{ nm}$  and radius  $R_{mt} \simeq 25 \text{ nm}$  the estimate is scaled up by the ratio  $R_{axon}/R_{tubule} \sim 40$  to  $h \leq (\rho_W/\rho) \times 208 \text{ m}$ . These bounds are consistent with observations.
  - (c) For the interior of a cylindrical structure like axon, microtubule of DNA strand one has  $V = \pi R^2 h$  and  $h \leq (4/3)(\rho_W/\rho)(R_{Pl}/R)^2 R_{Pl}$ . For axonal interior one obtains  $h \leq (\rho_W/\rho) \times 7 \text{ m}$ . For microtubule interior one has  $h \leq (\rho_W/\rho) \text{ m}$ . For DNA strand with  $R = R_{DNA} \sim 1 \text{ nm}$  one has  $h \leq (\rho_W/\rho) \times 625 \text{ m}$ . Also these bounds conform with empirical facts.

### 3.2.3 The flows associated with the water bridge

Both electric condition and bi-directional water flows associated with the water bridge have been observed.

1. In [D1] bi-directional flows with two-layered structure are reported and also bi-directional helical flows are mentioned (see the videos at <http://tinyurl.com/yyz27cpo>). Self-organization seems to be in question. Non-equilibrium thermodynamics requires energy feed naturally coming from the electrostatic energy: beakers would form an analog of battery very much like cell interior and exterior in biology. The net charges of beakers must be reduced to provide the energy so that either flow or both of them would be accompanied by electric current gradually reducing the charge difference. Charge flow in either direction is enough.

2. TGD based view about quantum self-organization suggests a similar picture. Coulomb energy would provide not only the energy needed to transform ordinary protons to dark protons at flux tubes but also the kinetic energy of flows.

One can imagine also a more detailed description of the flow by taking seriously the notions of EZ and CEZ having Planck mass as basic dynamical units.

1. The simplest model for the collection of EZs and CEZs would be in terms of two disjoint cubic lattices consisting of EZs and CEZs with each EZ and CEZs as nearest neighbours. Also ordinary water not accompanied by flux tube network would be involved if EZs and CEZs are spherical. Cubes containing EZ or CZ as ball looks like the most plausible option. Do dark flux tubes form a) a connected network or b) a collection of disjoint networks associated with the CEZs? For option a) the flux tubes should go through the corners of the cubes: this looks somewhat strange. For option b) hopping of the protons between CEZs would be necessary in order to have a current flow.
2. Consider first electric conduction. According to [D1] in electric conduction in water bridge (to be distinguished from water flow) quasi-free protons form about 80 per cent of current carriers: this is not the case in ordinary water. If the quasi-free protons are dark protons at flux tubes, the flow directed to the negatively charged beaker could occur as dark protons along the flux tube network inside CEZs connecting EZs and also small mass flow would be involved.
3. For the bi-directional hydrodynamical flow the net mass transfer should vanish so that the net flows of water should compensate each other. What is flowing in the hydrodynamical flows? Is it water molecules inside EZs and CEZs? Do dark protons at flux tubes inside CEZ participate the flow? If dark protons do not flow, there is net mass flow and co-flow of negative charge inside EZs reducing the charge difference.

Or are entire EZs and CEZs flowing? If so, there would be flows of positive and negative charge in opposite directions giving rise to a net current reducing gradually the charge difference and the electric potential just like in battery.

Should one give up the attempt to describe the flows using electrons and protons as basic units, and also the identification of EZs and CEZs as classical particles, and assume delocalized EZs and CEZs as quantal units assigning with them lattice wave functions as the quantum coherence in the scale of EZs (at least) indeed suggests. One would have an analog of electronic conductivity. The division to two cubic sub-lattices (say) would not look so counter-intuitive anymore. A possible biological analogy for the flow could be blood circulation: red blood cells would serve as analogs of EZs and their complement as an analog for CEZs.

### 3.2.4 How could one test experimentally the hypothesis about water Planckeons?

The presence of structures of size in the range  $[\sqrt{v_0/c}, 1] \times R_{Pl}$  - water Planckeons - could make itself visible in the spectrum of light of sound waves as wavelengths  $\lambda = R_{Pl}/n$ : this corresponds to THz frequency range. The frequencies would come as multiples  $f = f_{Pl}$ ,  $f_{Pl} = c/R_{Pl} \simeq 1.72$  THz. If the hypothesis about water Planckeons of size  $R \leq R_{Pl}$  as quantal objects is correct, one expect that these interactions are quantal and important in quantum biology. The emission of blackbody radiation at body temperature has peak at  $\lambda = 9.5 \mu$  so that the radiation in THz range has photon energies is below thermal energy. The value of  $h_{eff}/h > 18$  would increase the energy  $E = h_{eff}f$  above thermal energy.

Water is known to have a strong absorption of radiation in THz range .3 – 20 THz. In the range .3 – 6 THz the interaction is believed to allow classical modelling but above this range the excitations of rotational and vibrational states of water molecules become important and quantum treatment is necessary (see <http://tinyurl.com/y3647khw>).

Human skin consists of epithelial sheet (see <http://tinyurl.com/pxjedwz>) with thickness about  $50 \mu\text{m}$ , roughly  $R_{Pl}/3$ . Cornean epithelium in human retina has thickness 50 to  $52 \mu\text{m}$  (see <http://tinyurl.com/y34rdavv>). For  $v_0/c = 2^{-11}$  (estimated originally from the model of Nottale for planetary orbits as Bohr orbits [E1]) the lower bound for  $R$  is  $R_{min} = (v_0/c)^{1/6} R_{Pl} \simeq 48 \mu\text{m}$

and near to the thickness of epithelium. The comparison of the absorption of THz radiation by human skin in the frequency range .2 – 3 THz has demonstrated that the response is different for skin cancer and healthy tissues (see <http://tinyurl.com/y6cgv4u>). These findings might be seen as indications that water Planckons with size range  $[\sqrt{v_0/c}, 1] \times R_{Pl}$  could show themselves in biology.

If the hypothesis about lattice like structure with lattice cells having size  $R_{Pl}$  makes sense, even diffraction like effects in THz range are possible. Could epithelial sheets as analogs of 2-D lattices show diffraction effects?

Brillouin scattering (see <http://tinyurl.com/y85j867z>) is analogous to Raman scattering but takes place from acoustic modes (photons), charge displacement modes (polarons) and spin oscillation modes (magnons) rather than exciting or de-exciting vibrational and rotational states. The change of the wave length of light in Brillouin scattering is  $\Delta\lambda = (\Delta f/f)\lambda$ , where  $\Delta f$  corresponds to the frequency of the mode excited or de-excited. For scattering from water Planckons one would have  $\Delta f \sim 10^{12}$  Hz. For visible light with  $f \sim 5 \times 10^{14}$  Hz this would give  $\Delta\lambda \sim .5$  nm. Enhanced Brillouin scattering for these wave length changes in the range .1 – 1.5 nm for the visible frequency considered could serve as a signature for water Planckons.

## REFERENCES

### Theoretical Physics

- [B1] Mineev ZK et al. To catch and reverse a quantum jump mid-flight. arXiv:1803.00545 [quant-ph]. Available at: <https://arxiv.org/abs/1803.00545>, 2019.

### Condensed Matter Physics

- [D1] Wexler AD. Electrically excited liquid water: lessons from the floating water bridge. Available at: <http://edepot.wur.nl/378568>, 2013.
- [D2] Namin RM and Lindi SA. Equilibrium of the floating water bridge: a theoretical and experimental study. Available at: <http://tinyurl.com/y4zfoubj>, 2013.

### Cosmology and Astro-Physics

- [E1] Nottale L Da Rocha D. Gravitational Structure Formation in Scale Relativity. Available at: <http://arxiv.org/abs/astro-ph/0310036>, 2003.

### Biology

- [I1] The Fourth Phase of Water : Dr. Gerald Pollack at TEDxGuelphU. Available at: <https://www.youtube.com/watch?v=i-T7tCMUDXU>, 2014.

### Books related to TGD

- [K1] Pitkänen M. Quantum Model for Nerve Pulse. In *TGD and EEG*. Available at: <http://tgdtheory.fi/pdfpool/pulse.pdf>, 2006.
- [K2] Pitkänen M. *Quantum Physics as Infinite-Dimensional Geometry*. Online book. Available at: <http://www.tgdtheory.fi/tgdhtml/tgdgeom.html>, 2006.
- [K3] Pitkänen M. *TGD as a Generalized Number Theory*. Online book. Available at: <http://www.tgdtheory.fi/tgdhtml/tgdnumber.html>, 2006.

- [K4] Pitkänen M. Construction of Quantum Theory: More about Matrices. In *Towards M-Matrix: part I*. Available at: <http://tgdtheory.fi/pdfpool/UandM.pdf>, 2012.
- [K5] Pitkänen M. Are dark photons behind biophotons? In *TGD based view about living matter and remote mental interactions*. Available at: <http://tgdtheory.fi/pdfpool/biophotonslian.pdf>, 2013.
- [K6] Pitkänen M. Comments on the recent experiments by the group of Michael Persinger. In *TGD based view about living matter and remote mental interactions*. Available at: <http://tgdtheory.fi/pdfpool/persconsc.pdf>, 2013.
- [K7] Pitkänen M. *p-Adic length Scale Hypothesis*. Online book. Available at: <http://www.tgdtheory.fi/tgdhtml/padphys.html>, 2013.
- [K8] Pitkänen M. TGD as a Generalized Number Theory: p-Adicization Program. In *TGD as a Generalized Number Theory: Part I*. Available at: <http://tgdtheory.fi/pdfpool/visiona.pdf>, 2019.

## Articles about TGD

- [L1] Pitkänen M. Geometric theory of harmony. Available at: [http://tgdtheory.fi/public\\_html/articles/harmonytheory.pdf](http://tgdtheory.fi/public_html/articles/harmonytheory.pdf), 2014.
- [L2] Pitkänen M. Morphogenesis, morphostasis, and learning in TGD framework. Available at: [http://tgdtheory.fi/public\\_html/articles/morpho.pdf](http://tgdtheory.fi/public_html/articles/morpho.pdf), 2014.
- [L3] Pitkänen M. Pollack's Findings about Fourth phase of Water : TGD View. Available at: [http://tgdtheory.fi/public\\_html/articles/PollackYoutube.pdf](http://tgdtheory.fi/public_html/articles/PollackYoutube.pdf), 2014.
- [L4] Pitkänen M. About Physical Representations of Genetic Code in Terms of Dark Nuclear Strings. Available at: [http://tgdtheory.fi/public\\_html/articles/genecodemodels.pdf](http://tgdtheory.fi/public_html/articles/genecodemodels.pdf), 2016.
- [L5] Pitkänen M. Does  $M^8 - H$  duality reduce classical TGD to octonionic algebraic geometry? Available at: [http://tgdtheory.fi/public\\_html/articles/ratpoints.pdf](http://tgdtheory.fi/public_html/articles/ratpoints.pdf), 2017.
- [L6] Pitkänen M. Philosophy of Adelic Physics. In *Trends and Mathematical Methods in Interdisciplinary Mathematical Sciences*, pages 241–319. Springer. Available at: [https://link.springer.com/chapter/10.1007/978-3-319-55612-3\\_11](https://link.springer.com/chapter/10.1007/978-3-319-55612-3_11), 2017.
- [L7] Pitkänen M. Philosophy of Adelic Physics. Available at: [http://tgdtheory.fi/public\\_html/articles/adelephysics.pdf](http://tgdtheory.fi/public_html/articles/adelephysics.pdf), 2017.
- [L8] Pitkänen M. Re-examination of the basic notions of TGD inspired theory of consciousness. Available at: [http://tgdtheory.fi/public\\_html/articles/conscrit.pdf](http://tgdtheory.fi/public_html/articles/conscrit.pdf), 2017.
- [L9] Pitkänen M. About dark variants of DNA, RNA, and amino-acids. Available at: [http://tgdtheory.fi/public\\_html/articles/darkvariants.pdf](http://tgdtheory.fi/public_html/articles/darkvariants.pdf), 2018.
- [L10] Pitkänen M. Could also RNA and protein methylation of RNA be involved with the expression of molecular emotions? Available at: [http://tgdtheory.fi/public\\_html/articles/synapticmoods.pdf](http://tgdtheory.fi/public_html/articles/synapticmoods.pdf), 2018.
- [L11] Pitkänen M. Emotions as sensory percepts about the state of magnetic body? Available at: [http://tgdtheory.fi/public\\_html/articles/emotions.pdf](http://tgdtheory.fi/public_html/articles/emotions.pdf), 2018.
- [L12] Pitkänen M. Getting philosophical: some comments about the problems of physics, neuroscience, and biology. Available at: [http://tgdtheory.fi/public\\_html/articles/philosophic.pdf](http://tgdtheory.fi/public_html/articles/philosophic.pdf), 2018.
- [L13] Pitkänen M. Maxwells lever rule and expansion of water in freezing: two poorly understood phenomena. Available at: [http://tgdtheory.fi/public\\_html/articles/leverule.pdf](http://tgdtheory.fi/public_html/articles/leverule.pdf), 2018.

- [L14] Pitkänen M. Copenhagen interpretation dead: long live ZEO based quantum measurement theory! Available at: [http://tgdtheory.fi/public\\_html/articles/Bohrdead.pdf](http://tgdtheory.fi/public_html/articles/Bohrdead.pdf), 2019.
- [L15] Pitkänen M.  $M^8 - H$  duality and consciousness. Available at: [http://tgdtheory.fi/public\\_html/articles/M8Hconsc.pdf](http://tgdtheory.fi/public_html/articles/M8Hconsc.pdf), 2019.
- [L16] Pitkänen M.  $M^8 - H$  duality and the two manners to describe particles. Available at: [http://tgdtheory.fi/public\\_html/articles/susysupertwistor.pdf](http://tgdtheory.fi/public_html/articles/susysupertwistor.pdf), 2019.
- [L17] Pitkänen M. Quantum self-organization by  $h_{eff}$  changing phase transitions. Available at: [http://tgdtheory.fi/public\\_html/articles/heffselforg.pdf](http://tgdtheory.fi/public_html/articles/heffselforg.pdf), 2019.
- [L18] Pitkänen M. Trying to understand why ramified primes are so special physically. Available at: [http://tgdtheory.fi/public\\_html/articles/ramified.pdf](http://tgdtheory.fi/public_html/articles/ramified.pdf), 2019.