Could dark protons and electrons be involved with di-electric breakdown in gases and conduction in electrolytes?

M. Pitkänen
Email: matpitka6@gmail.com.
http://tgdtheory.com/.

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Abstract

The TGD inspired model for "cold fusion" led to ask whether electrolytes are really understood in standard chemistry. The question of my friend related to di-electric breakdown in gases led me to consider this problem more precisely. In this article I will first consider di-electric breakdown and then ionic conduction in electrolytes from TGD point of view to see whether the hypothesis stating that dark matter consists of phases of ordinary matter with non-standard Planck constant $h_{eff} = nh_0$ following from adelic physics could provide concrete insights into these phenomena.

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1 Introduction

I have had long time the intuitive feeling that electrolytes are not really understood in standard chemistry and physics and I have expressed this feeling in the TGD model of "cold fusion" [L2] [K3]. This kind of feeling of course induces immediate horror reaction turning stomach around. Not a single scientist in the world seems to be challenging the age-old chemical wisdom. Who am I to do this? Perhaps I really am the miserable crackpot that colleagues have for four decades told me to be. Do I realize only at the high age of 68 that my wise colleagues have have been right all the time?

The question of my friend related to di-electric breakdown in gases led me to consider this problem more precisely. I will first consider di-electric breakdown and then ionic conduction in electrolytes from TGD point of view to see whether the hypothesis stating that dark matter consists of phases of ordinary matter with non-standard Planck constant $h_{eff} = nh_0$ [K4] following from adelic physics [L4, L5] could provide concrete insights to these phenomena.

2 Ionization in di-electric breakdown

One can start from a model for the dielectric breakdown of gas (see http://tinyurl.com/y9v9bkay). The basic idea is that negatively charged cathode emits electrons by tunnelling in electric field and these accelerate in the electric field and ionize atoms provided they travel a distance longer than the free path $l = 1/n\sigma$ before collision. Here n is number density of atoms and σ collision cross section, in geometric approximation the cross sectional area of gas atom. This implies a lower bound on the number density n of gas atoms. On the other hand, too low density makes also ionizations rare.

The positive ions in turn are absorbed by cathode and more electrons are liberated. In gas dielectric breakdown results if the field strength is above critical value E_{cr}. For air this one has $E_{cr} = 3$ kV/mm.

1. Cathode with a sharp tip liberates electrons. The electric field near the tip is very strong an in a reasonable approximation has strength

$$E = \frac{V}{r} \ , \tag{2.1}$$

where r is radius of curvature of the tip and V is the voltage with respect to earth. If r is small enough, electron is able to tunnel from the metal.

2. The tunnelling current from electron can be deduced from a simple model based on Scrödinger equation in one-dimensional potential having the form $U(x) = -\Phi_w + \frac{Vx}{r}$ in the non-allowed region. One assumes that one can describe the electron using analog of plane wave $exp(ikx)$ with kx replaced with $\int_0^x k(x)dx = i\int_0^x p(x)dx/\hbar$ with imaginary momentum $p(x) = i\sqrt{2m|E-U(x)|}$ in the non-allowed region. Tunnelling current is proportional to the exponential factor

$$R = exp(i\int k(x)dx) \tag{2.2}$$

having interpretation as tunneling probability.

3. Tunneling rate is highest near Fermi energy and at this energy the tunnelling rate is

$$R = exp(-8\pi\frac{\sqrt{2m\Phi_w^3}}{3hE}) \ . \tag{2.3}$$

Here m is electron's mass and Φ_w is work function of the metal telling the height of the potential well in which electron resides. In the model of photo-electric effect the energy of photon needed to kick out electron from metal must be above Φ_w. The exponential factor approaches extremely rapidly but for small enough curvature radii and it can be sufficiently near to unity.

Remark: Imaginary momentum does not make sense in classical mechanics. What is interesting that in classical TGD the classical conserved quantities are in general complex numbers and the analogs of virtual particles are on mass shell states with complex moments as also in twistor Grassmannian approach having 8-D generalization in TGD framework. Could tunnelling have classical space-time description in TGD framework?

4. The electric field needed in the tip cannot be much larger than

$$E_{max} = \frac{V}{r} \sim 8\pi\frac{\sqrt{2m\Phi_w^3}}{3h} \tag{2.4}$$

to guarantee that the exponent is not too small. If one has $h \to h_{eff} = n \times h_0 > h$ ($h = 6h_0$ is a good guess [L1, L6]) tunnelling rate increases. This effect might serve as a signature for large value of h_{eff} [L3]. Tunnelling would be to magnetic flux tubes carrying dark electrons.

What is needed is di-electric breakdown in a manner already described.

1. Electrons ionize atoms and the resulting electrons cause more ionizations. Also the positive ions collide with cathode and generate new electrons. A continual discharge, arc generation, would be the outcome.

   A rough criterion for ionization is that the free path $l = 1/n\sigma$ of electron is so large that the electron gains so large energy in the electric field E that it exceeds ionization energy. The condition is $El \geq E_I$. Small density increases l but also decreases the number of collisions so that there is some optimal density and pressure for the di-electric breakdown to occur. If electrons are dark they can travel along flux tubes, which would increase the free path in electric field and increase the rate of ionization.

2. The generation of arc is described by Paschen's law giving the breakdown voltage and discovered 1989 empirically by Paschen (see `http://tinyurl.com/heezy8f`).

3 Do we really understand ionic conduction in electrolytes?

One must now explain why ions can act as charged carriers in relatively weak electric fields. Concerning the production of electrons at electrode the situation remains the same. In electrolyte however the free path is much shorter than in gas since the density n is orders of magnitude higher. Therefore the ionization mechanism in electrolytes must be different - at least in standard physics framework. One can of course ask whether the large value of h_{eff} might help both in the generation of dark electron at cathode and also help to increase the free path of electron so that they gain higher energy in the electric field of electrolyte typically much lower that in dielectric breakdown.

The mechanism for the dissolution of ions in water involves neither electrodes nor electric field. The ionization of NaCl in water serves as a good example.

1. Na and Cl in NaCl are already ionized since ionic bond is in question. In dissolution giving rise to Na^+ and Cl^- ions NaCl ionizes into Na^+ and Cl^- in water. The sizes of ions vary in the range .2- 2 Angstrom. The explanation is that the presence of polar water molecules of size about 3 Angstrom of which some have ionized to OH^- and H^+ leads to a competition and the presence of OH^- and H^+ breaks ionic NaCl bonds and dissolves NaCl. Approximating the situation as one-dimensional would suggest that NaCl corresponds to a potential well for e^2/r potential. From the distance r between Na and Cl one obtains an estimate for the Coulomb potential energy depending on distance. For $r = 2$ Angstrom it is about 50 eV and therefore rather high.

2. The presence of OH^- or H^+ means second potential well. The Coulomb potentials of say Cl^- and OH^- acting on H^+ sum up and double potential well is created. In the original situation Na^+ is the potential well of Cl^-. The closer the Cl^- and OH^- (or H^+ and Na^+ ions are, the lower the barrier between the two wells is and the higher the tunnelling probability for Na^+ from the potential well of Cl^- to that of OH^- is. This can make possible tunnelling of Na^+/Cl^- with subsequent formation of ionic bound state NaOH/HCl.

   The tunnelling probability is also now an exponential analogous to that appearing in the previous formula and proportional to $1/h$. Ions must however get so close that the potential barrier is low enough. The rate for close encounters must be therefore high enough.

   Is this really the case or could h_{eff} come in rescue? Could the dark protons H^+ with $h_{eff} = n \times h$ at magnetic flux tubes possibly formed in the ionization of water molecules to OH^- and H^+ play some role. Could also dark valence electrons assignable to OH play a role. Could one think that dark H^+ and e^- of H_2O can reside at long flux tubes assignable to H_2O so that H_2O would look like $OH^- + H^+$. As a matter fact, a more realistic model replaces flux tubes with flux tube pairs since there are reasons to assume that the flux tubes carry monopole flux and they must form closed units [L3]. Flux tube pairs are also central for the TGD based model of high Tc superconductivity [K1, K2].

   Same would apply to HCl and NaOH. This leads to several variants of these molecules in which proton or electron or both are dark and resides at long flux tube. External electric field could induce lengthening of this flux flux tube pairs or at least the motion of dark proton and electron along it. These molecules would look like having long charged tentacles formed

by flux tube pairs parallel or antiparallel to the direction of electric field. Electric field would force the charged flux tube pair to move so that it would point to the direction to which charged particle moves in the field.

3. According to standard physics this process generates only different ionic bound states HCl and NaOH are formed from NaCl and H_2O and vice versa. One does not obtain Na^+ and Cl^- serving as charge carriers. How could the presence of the relatively weak electric field in electrolyte make possible electric currents if there are no charge carriers?

4. Are HCl and NaOH in water really what they would be in gas? Could HCl in water be a bound state of H^+ and Cl^- such that H^+ has a large value of h_{eff}. Could also Cl^- be Cl for which electron could be dark electron at flux tube? This would make the size of HCl much larger than in gas and the ions involved look like free charge carriers in much longer scale. Could same apply also to NaOH, NaCl ad H_2O.

   Could the fundamental current carriers be dark protons and dark electrons at dark flux tubes pairs? Consider a long tentacle formed by a long flux tube pair carrying dark proton or electron with the direction of flux tube pair determined by the sign of the electric force on the charge. This tentacle could reconnect with a neutral tentacle and the charge would be transferred to the latter. This flux tube pair would be in turn driven by by the field perhaps also inducing the increase of h_{eff} (requiring energy provided by the field) and therefore flux tube length so that it points to the same direction as the original long tentacle. The outcome would be conduction based on the hopping of protons and electrons over a distance of the order of tentacle length. This hopping mechanism could serve as a universal mechanism of conduction in electrolytes and also in living matter.

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