About the Biefeld Brown effect

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Matti Pitkänen

orcid:0000-0002-8051-4364.
email: matpitka6@gmail.com,
url: http://tgdtheory.com/public_html/,
address: Rinnekatu 2-4 A 8, 03620, Karkkila, Finland.

Abstract

Biefeld Brown effect is one of the effects studied by "free energy" researchers. What happens is that an asymmetry capacitor for which the electrodes are of different size starts to move in the direction of the smaller electrode. The so called emdrive could be also based on this effect. Recently I learned of the experiments carried out by Buhler's team. An acceleration of 1 g is achieved for a capacitor-like system in vacuum and the effect increases rapidly with the strength of the electric field between the electrodes. This raises the question whether new physics is involved: either as a failure of the momentum conservation or as a presence of an unidentified system with which a momentum transfer takes place.

In this article I consider the TGD basic model in which the third system is identified as the electric field body (FB) associated with the system. The key idea is that electronic momentum is pumped from the electrodes to their FBs: an electron is transferred to the FB, leaves some of its momentum to FB and drops back and in this way gives rise to a recoil. For the smaller electrode the quantum coherence is higher and the pumping is more effective. This gives rise to the Biefeld Brown effect, perhaps even in the situation when the dielectric is present. There is also a net transfer of electrons momentum to the positive electrode, which reduces the voltage while keeping the system neutral and provides in this way electrostatic energy to the kicked electrons. This explains why the effect is stronger when the smaller electrode is positively charged.

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1 Introduction

Biefeld Brown effect is one of the effects studied by "free energy" researchers. What happens is that an asymmetry capacitor for which the electrodes are of different size starts to move in the direction of the smaller electrode. The so called emdrive (see `http://tinyurl.com/zkwoehe`), which I have commented in [K3] [L1] could be also based on this effect. There has been a lot of overhyping such as vehicles moving with light-velocity to Mars and the failure of momentum conservation byt the Biefeld Brown effect is real.

The recent experiments carried out by Buhler's team using capacitor-like systems in vacuum chamber to achieve a levitation in the gravitational field of Earth (see this). If this is really the case, new physics is involved.

1.1 The original experiments of Brown

Biefeld Brown effect is discussed in [H1, H2, H5] (see also this). The electric fields associated with the capacitors are about 30 kV/dm, which is about 10 percent of the electric field 30 kV/cm causing dielectric breakdown in air. Note that the electric field of Earth is 10-30 V/dm and therefore roughly by a factor 1/1000 weaker.

Brown makes several important statements, including:

1. The acceleration is in the direction of the smaller electrode.
2. The greatest force on the capacitor is created when the small electrode is positive. This could be understood if positive ionic currents are responsible for the effect.
3. The effect occurs in a dielectric medium (air).
4. The effect can be used for vehicle propulsion or as a pump of dielectric fluid.
5. Brown's suggest that the effect involves ionic motion.
6. The detailed physics of the effect is not understood.

Standard physics based models for the effect are discussed in [H5]. The models assume that the cm motion is due to the loss of energy and momentum to the environment and fail if the effect is possible in vacuum. The first model assumes ionic wind between the electrodes and predicts effect, which is 3 orders of magnitude too small. The model based on ionic drift is a rough order of magnitude model and predicts that the effect can have an order of magnitude consistent with the findings. The reason why the ionic wind predicts a smaller effect is that the absence of dissipation tends to reduce the effect since the ions arriving to the opposite electrode induce an opposite recoil.

1.2 Interview of Charles Buhler by Tim Ventura

The interview of Charles Buhler by Tim Ventura (see this) gives more details about what has been found in the experiments giving a thrust which is now around one g. Buhler's team has been developing the propellantless propulsion based on asymmetric capacitor-like systems understood in a very general sense, i.e. there are just two electrodes which are asymmetric. The work is completely independent of NASA and has been patented. Consider first the experimental arrangement.

1. Electric field is more intense at the smaller electrode and is believed to make the effect larger. In the experiments Brown the effect was larger when the smaller electrode positively charged.
2. The electrodes are cased which means that there is no leakage of charge between them. The claim is that this prevents all kinds of leakage currents between the electrodes. The system is also enclosed in high vacuum and this allows the use of lower voltages.

Buhler emphasizes that there are profound differences between the situation in the recent experiments and experiments of Biefeld Brown.

1. In standard physics the center of mass of an isolated system must remain at rest. Now the system is in a vacuum chamber and there is no charge leakage between the electrodes and the findings demonstrate that there is a center of mass motion in vacuum. Therefore there should exist a momentum and energy exchange with some unidentified system. Charges and/or radiation should leave the electrode to produce a recoil and recoils not compensate for each other and the asymmetry of the system guarantees this.

2. Mere charge and electric field are enough to generate the thrust and no external energy is needed. This suggests that the electrostatic energy provides the needed energy.

3. There are two types of charges involved. The free charge appearing in conductors and the bound charge appearing in insulators. The interpretation could be in terms of electrons. Bound charge could correspond to valence electrons which do not become conduction electrons but something else. It is reported that at low voltages free charge dominates the effect and at higher voltages bound charge dominates. The interpretation could be in terms of ionization in high enough voltage in which bound charges go somewhere. The bound electrons increase the thrust dramatically. In the latter case an ionization of atoms is required.

What happens to the electrons?

1. Without a transfer of electron momentum to the degrees of freedom of X, the generation of the center of mass momentum is impossible. The electrons transferred to X end up to the opposite electrode or drop back to the original electrode and in this process pump momentum to X. The asymmetry suggests that the pumping from the smaller electrode is more effective.

2. Suppose that the electrons get their energy from the electrostatic energy of the capacitor-like system and the net charge of the system remains zero. This requires that there is a net transfer of negative to the positive electrode. It is easy to see that the accumulation of negative charge to the third party system, call it X, is not possible. Therefore the momentum of electrons must be dissipated or transferred to some internal degrees of freedom of X.

3. One cannot exclude the possibility that some fraction of electrons remain to X for a relatively long time. This would lead to a generation of a net positive charge. The capacitor system would experience a force in the electric field of Earth. If there is a third system involved then the capacitor type system and the third system behaves like an electric dipole in the electric field of Earth. Since the Earth is negatively charged, the force would tend to decrease the thrust. In this case a current is needed to preserve the charges of the electrode.

2 TGD based model of the effect

2.1 Basic ideas of the TGD based model

I have already earlier commented on the Biefeld Brown effect from the TGD point of view [K2, K4] [L1]. The TGD inspired model to be discussed involves the following basic ideas.

1. The new view of space-time as 4-surface in $H = M^4 \times CP_2$, which also implies the notion of field body as a generalization of the classical physics based view of field. Maxwellian magnetic and electric fields are replaced by a field body which corresponds to a space-time surface with a very large size assignable to the system. The field body can be magnetic or electric and it has flux tubes and flux sheets as body parts [L4]. Also the notion of gravitational body makes sense and is central in the TGD inspire quantum biology [L3, L2].

2. TGD predicts two kinds of magnetic flux tubes. Monopoles flux tubes, which have a closed cross section and Maxwellian half-monopole magnetic flux tubes having boundary, which I have proposed to be important in the temperature region above the transition temperature in the case of high Tc superconductors [L5]. This distinction is made quite generally for the

magnetic flux tubes and plays a key role in the TGD based quantum biology and electric flux tubes can be identified as deformations of the magnetic flux tubes.

The simplest model for the electric flux tube is as a small deformation of the magnetic flux tube. Therefore there are two kinds of electric flux tubes: closed monopole flux tubes and the Maxwellian ones.

3. The number theoretic vision of TGD predicts a hierarchy of Planck constants h_{eff} labelling the phases of ordinary matter residing at the field bodies. These phases behave like dark matter. The larger the value of h_{eff}, the longer the quantum coherence scales are and the field bodies can be macroscopic quantum systems. Their algebraic complexity also increases with h_{eff}, which is essentially the dimension of algebraic extension of rationals characterizing the space-time region in question. One can say that the field body serves as a "boss" of the system to which it is associated. The field body induced the coherence of the ordinary biomatter.

   TGD predicts that classical gravitational fields of the Sun, Earth and other planets are responsible for very large values of effective Planck constant $h_{eff} = h_{gr}$ for ordinary particles located at the gravitational monopole flux tubes. In [L4] the generalization of this proposal for electric fields with effective Planck constant $h_{eff} = h_{em}$ is discussed. Examples are electric fields of DNA, cell, ionospheres of the Earth and Sun, and also of large capacitor-like systems.

   The electric monopole flux tube could carry dark electrons with $h_{eff} = h_{em}$. In the case of the Earth's magnetic field the monopole flux tubes would contribute 2/5 of the magnetic flux. One must also ask whether the flux tubes could be deformed monopole flux tubes associated with the Earth's magnetic field.

4. Pollack effect [I2, I1, I4, I3] is central in the model. The increase of h_{eff} requires energy and in the Pollack effect water is irradiated with electromagnetic radiation at visible and IR frequencies. This induces the transfer of every 4:th proton somewhere and generation of exclusion zone, which has the stoichiometry $H_{1.5}O$, forms a layer-like structure formed by 2-D hexagonal lattices, and seems to have a reversed arrow of thermodynamic time. The proposal is that the protons go to the magnetic body of the system and become dark protons with a very large value of h_{eff}.

   Pollack effect generalizes [L4]. The energy needed to increase h_{eff} can come from the formation of molecules as bound states of atoms and this could be essential for the formation of biomolecules and would mean a new kind of chemistry. Also electrons can be transferred to dark electrons at magnetic or electric bodies and in the case of capacitor-like systems electrostatic energy could make possible the increase of h_{eff}.

2.2 Assumptions of the model

The previous considerations fix the assumptions of the model to a high degree.

1. Conduction electrons and valence electrons of insulators are transferred to the flux tubes of electric or magnetic field body (FB) as dark charges as in the generalized Pollack effect [I2, I1, I4, I3]. The effect is present in absence of external current suggests that only electrostatic energy is used to induce the generalized Pollack effect. In this case there must exist a net charge transfer from the negative electrode to the positive electrode taking place via FB. Only momentum transfer to the FB is possible and could take place by dissipation or by transfer to its internal non-thermal degrees of freedom. The large value of h_{eff} suggests that dissipation is small.

2. The electrons transferred to the FB from a given electrode can end up either to the opposite electrode or back to the original electrode. This would make possible a generation of recoil momentum by pumping momentum to the FB. If this effect is larger for the smaller electrode , it could explain most of the effect. This quantum mechanism might be at work also when the dielectric is present.

3. Is the FB associated with the capacitor-like system or with a larger system? If it is associated with the capacitor-like system, one expects that the cm motion is possible only in a finite region. If it is associated with, say, the electric body of Earth, a larger scale motion could be possible. The relevant part of the FB is located between the electrodes?

4. The net momentum transferred to a given flux tube is naturally parallel to it. The recoil momentum is in the opposite direction. The asymmetry of the system favors momentum transfer directed towards the opposite electrode meaning that the flux tubes are in the intermediate region. Therefore the direction of the recoil momentum is away from the opposite electrode and the smaller electrode should give rise to a larger recoil momentum.

   The identification of flux tubes as monopole flux tubes is natural if the Maxwellian leakage currents are excluded by the casing. Therefore the effect would demonstrate the existence of monopole flux tubes.

5. In the recent case, ions are not carriers of the current so that it is not quite obvious whether the effect need not be larger when the smaller electrode is positively charged. However, if the electrodes have opposite charges and the smaller electrode is positive, a net transfer of the electrons and momentum to it occurs and enhances the effect.

2.3 A model for the capacitor-like system

Consider first a model for the capacitor-like system inspired by the model for the electric body of Earth.

1. TGD predicts large scale quantum coherence for charged systems [L4] and this could be highly relevant for the effect. The electric Planck constant for a pair formed by a charged particle with charge e and for charged system with charge Q is $\hbar_{eff} = \hbar_{em} = Qe/\beta_0$, where $\beta_0 = v_0/c \leq 1$ is a velocity parameter. Now the system with charge $\pm Q$ would be electrode. One could assume that the values of β_0 are the same for the two electrodes. For the pair formed by the electrodes electric Planck constant would be given by $\hbar_{em} = Q^2/\beta_0$. $\hbar_{em}$ would characterize charged particles at the electric body of the system consisting of electric flux tubes.

2. Electric field strength, rather than voltage, is relevant for the effect. The charge Q of the capacitor as the electric flux $Q = \epsilon_0 \int E \cdot dS$ is indeed proportional to the electric field and this suggests that macroscopic quantum coherence might be important [L4]. This $Q = \epsilon_0 ES$ for capacitor plate. The effect could become large for strong field strengths suggesting that the transfer of charges to the electric body is a collective quantum effect proportional to the square N^2 of the number N of charges transferred. If the increase of voltage in the experiments of Buhler's team has been achieved by keeping the size constant, the dramatic increase of the thrust could be understood in this way.

3. For a particle of mass m, the electric Compton length $\Lambda_{em} = h_{em}/m = 2\pi Qe/\beta_0 m$ serves as a good guess for the lower bound for the quantum coherence length and is for proton by a factor 1/2000 smaller than for electron. The first guess for the thickness d of the electric flux tube is as $d = \Lambda_{em} = 2\pi Qe/\beta_0 m$. Here m would refer to electron mass. This would explain why the transfer of electrons is what matters in the experiments. Hitherto it has been assumed that only valence electrons can become dark having $h_{eff} \geq h$ and this conforms with the identification of bound electrons as valence electrons.

   Using the values $E = 300$ kV/m, $\epsilon_0 = 8.85 \times 10^{-12}$ C/Vm, $C = 6.24 \times 10^{18} e$, $\lambda_{em} = h/m_e = 2.48 \times 10^{-12}$ m, $d \sim \Lambda_{em} = 24.3 \times (S/dm)^2$ cm. The order of magnitude is few dm and makes sense.

4. Can one assume that the entire electrodes form quantum coherent systems or should one assume that only the flux tubes are such systems? The entire electrodes need not be quantum coherent systems. This was found in the case of the electric field of Earth. It is possible that a bundle of flux tubes forms a quantum coherent system.

   If only a single flux tube is a quantum coherent system, a natural first guess would be that the flux tube radius d is equal to the electric Compton length so that one would have

$d = 2\pi Qe/\beta_0 m$. For instance, if the smaller electrode corresponds to a single flux tube, it decompose to smaller flux tubes near the larger electrode giving rise to smaller quantum coherent units with charge $Q_{large}/Q_{small} = S_{small}/S_{large}$ and having therefore also a smaller values of electric flux and of Maxwellian electric field. Quite generally, the flux tubes from the smaller electrode would decompose in this way at the larger electrode. In this case the quantum coherent transfer rate from smaller electrodes would be high.

2.4 Why the smaller electrode gains a larger recoil momentum?

The geometric asymmetry of the electrodes, or more precisely the convergence of flux tubes at the smaller electrodes, is believed to somehow explain the thrust towards the smaller electrode. One can imagine several options but the following is perhaps the simplest one.

1. Suppose that the flux tubes are U-shaped closed flux tubes connecting the electrodes either via the region between the electrodes. Assume that electrons are transferred to dark electrons at these flux tubes and that the transfer of electrons to FB and back to the same electrode pumps momentum to the FB and induces recoil effect at both electrodes.

2. The simplest assumption is that a single flux tube acts as a quantum coherent unit and that the smaller electrode corresponds to a single coherent unit which splits to several near the larger electrode. The charges $Q(tube)$ of the flux tubes near the small *resp.* large electrode are in the ratio $Q_{small}/Q_{large} = S_{small}/S_{large}$ of their areas. By quantum coherence the rate for the momentum transfer is proportional to $Q^2(tube)$ and is therefore larger near the smaller electrode. The transfer rates are proportional to the square of the charge per flux tube and in the ratio $R_{large}/R_{small} = (S_{small}/S_{large})^2$. This would predict that the rate of momentum transfer is higher at the smaller electrode.

   This mechanism of quantum coherence would explain why asymmetry is important. The net transfer of charge and momentum to the positively charged electrode when total charge of the capacitor system remains vanishing, could predict that the effect is larger for the positively charged smaller electrode.

Needless to emphasize, the model involves large uncertainties but avoids obvious conflicts with the empirical facts.

2.5 Could the model of Biefeld Brown effect apply to rotating magnetic systems?

This model could be also applied to a rather massive rotating magnetic system studied by Russian researchers Godin and Roschin [H3, H4] (see this), which I have tried to understand during years [K1].

1. The system consists of a stator and rollers rotating around it. Also the effect of a radial electric field was studied. The high voltage between stator and electrodes outside the rollers varied in a range 0-20 kV. Therefore a capacitor-like system is in question. Positive potential was associated with the stator so that the force experienced by electrons was towards the electrodes. This generates a strong radial electric field and there is an ionization of air around the rotating magnet, which could be caused by high energy electrons from the surface of the rotor as in coronal discharge.

2. What happens is that the system begins to accelerate spontaneously as the rotation frequency approaches 10 Hz, the alpha frequency of EEG. Rather dramatic weight reduction of 35 per cent and a generation of cylindrical magnetic walls with B=.05 Tesla parallel to the rotation direction are reported. The sign of the effect depends on the direction of rotation.

The situation resembles in many respects to that in the Biefeld Brown effect.

1. Could the Pollack effect feed electrons to the magnetic and/or electric FB of the system. The electrons would also leave some of their angular momentum to the FB and drop back.

Otherwise the rotors develop a positive charge $Q = \omega BS$ proportional to the rotation frequency ω, magnetic field B and the area S of the vertical boundary of the cylinder, as in the Faraday effect.

The pumping of electrons to the FB would generate both the momentum and angular momentum as a recoil effect. Now the vertical components of momentum and angular momentum in z-direction would be involved. In the first approximation, the magnetic field can be modelled as a dipole field in Maxwellian theory.

2. Rollers are rotating magnets. What is interesting is that in the Faraday effect a rotating magnet develops a radial voltage proportional to the rotating frequency and magnetic field. One expects that the same occurs for the rollers. This cannot be understood in Maxwell's theory as induction since the motion is not linear and the calculation of the voltage using the same formula requires a generation of a charge density. In TGD, the assumption that the vector potential of the magnetic field rotates with the magnet, explains the effect. Could this charge density be due to a transfer of electrons to the FB of the system? Positive charge density would be generated and create a force opposite to the direction of the Earth's gravitational acceleration so that the Faraday effect for the rollers cannot explain the findings.

3. One expects that the vector potentials for the magnetic fields of rollers rotate as in the Faraday effect. Also the magnetic fields associated with the rollers or rather, their flux tubes should rotate. This could lead to a twisting of the flux tubes. The twisting would suggest that the flux tubes of FBs of the rollers are helical monopole flux tubes (by rotation) emerging from the top and retung back at the bottom of the roller system. There is an obvious analogy with the solar magnetic field.

   Could this generate momentum and angular momentum recoils? The two ends of the rollers should generate different recoils. The only asymmetry between the top and bottom is that the Earth surface bounds the system at the bottom. Could this give rise to a higher degree of quantum coherence at the upper ends of the rollers, which could give rise to a non-vanishing net acceleration and angular acceleration.

4. The observed magnetic walls could correspond to the return flux associated with the magnetic field of the rollers. That they are walls suggests that the flux tubes from the rollers fuse to a single flux wall and this gives rise to a quantum coherence. That the return flux consists of several magnetic walls rather than a single one suggests that the magnetic wall emerging from the roller system decomposes to these walls and the scale of quantum coherence is reduced. If the fluxes of walls return separately to the lower ends of rollers the degree of quantum coherence would be lower and this could give rise to a net effect.

5. Where could the energy of rotation and lift come from? Does it come from some external source, say the MB of the Earth? This could relate to as the 10 Hz cyclotron resonance assignable to the Fe ions in the "endogenous" magnetic field $B_{end} = 2B_E/5$ assigned to the monopole flux tubes as the model for the findings of Blackman suggests [J1]?

   Does the energy come from the internal magnetic energy of the stator magnet or of rollers? Or does the energy come from the electrostatic energy associated with the horizontal electric field between electrodes and rollers as in the Biefeld Brown effect. This voltage should gradually reduce if this is the case.

3 Appendix: summary of the TGD view of the Biefeld-Brown effect

The following gives a brief summary of the TGD view of the Biefeld Brown effect.

3.1 Basic assumptions and questions

The following assumptions look natural.

1. The total charge of the two-electrode system remains zero.

2. Electrostatic energy is used to transfer electrons from the negatively charged electrode to the opposite electrode. This implies that the electric field gets weaker and the charges of electrodes decrease in magnitude in the process.

3. The rate of the momentum transfer by free electrons from the negatively charged electrode is proportional to the electric force in turn proportional to the electric field E, which is always larger at the smaller electrode so that the acceleration of the center of mass is towards the smaller electrode.

The following questions should be answered.

1. Momentum conservation requires a third system with which energy and momentum is exchanged. What is this third system?

2. Why there the electrode sizes must be different and why negative charge for the smaller electrode produces larger effect? Do the free electrons, which are transferred between the plates, differ from the ordinary electrons?

3.2 Hierarchy of effective Planck constants h_{eff}

The proposal is that the free electrons are characterized by effective Planck constant larger than h and identifiable as what I call electric Planck costant.

1. Effective Planck constant h_{eff} is an outcome of the number theoretic vision of TGD and is given by

$$h_{eff} = nh_0 \quad , \quad h_0 < h \quad .$$

This gives effective Compton length as a lower bound for quantum coherence length

$$\lambda_{eff} = \frac{h_{eff}}{m} = \frac{h_{eff}}{h}\lambda_c$$

Quantum coherence becomes arbitrarily long scales. These phases behave like dark matter but are not galactic dark matter. Missing baryonic matter would correspond to these phases.

2. Nottale's gravitational Planck constant is given by

$$\hbar_{gr} = \frac{GMm}{\beta_0} \quad , \qquad \beta_0 = \frac{v_0}{c} \leq 1 \quad .$$

The gravitational Compton length is given by

$$\Lambda_{gr} = \frac{GM}{\beta_0} = \frac{\pi r_s}{\beta_0} \quad .$$

Quantum gravitational coherence possible in arbitrarily long scales.

3. One can define the notion of electric Planck constant in the same way:

$$\frac{\hbar_{em}}{\hbar} = \frac{Qe}{\hbar\beta_0} = N \times \frac{e^2}{\hbar\beta_0} = N \times \frac{4\pi\alpha}{\beta_0} \quad .$$

In the recent case $Q = Ne$ is the charge of the electrode or of the quantum coherence region which is a flux tube starting from the electrode.

The electric Compton length of electron is defined in the same way

$$\lambda_{em,e} = \frac{\hbar_{em}}{m_e} = N \times \frac{4\pi\alpha}{\beta_0}\lambda_e \quad .$$

The idea is that there is roughly one electron per atom involved, suggests that one has $\lambda_{em,e} \sim Na_0$, where $a_0 = \lambda_e/2\alpha$ is Bohr radius as estimate for the atomic size scale. This condition gives the estimate $\frac{4\pi\alpha}{\beta_0} = a_0/\lambda_e = 1/2\alpha$ giving the estimate

$$\beta_0 = 8\pi\alpha^2 \quad .$$

3.3 A simple model for the flux tubes

Electric flux decomposes to flux quanta and for flux quanta the electric field can be strong. The measured electric field is the average over flux tube electric fields.

If one knows the charge $Q = Ne$, one can deduce $\lambda_{em,e}$, which gives a reasonable estimate for the radius of the flux tubes as electric Compton length

$$r = \lambda_{em,e} = N \times \frac{4\pi\alpha}{\beta_0}\lambda_e \ .$$

This gives an estimate for E.

1. Gauss law gives

   $$ES = Q = Ne \ .$$

   One has $S = x\pi r^2$. For ordinary flux tubes one has $x = 1$ and for monopole flux tubes $x = 4$.

2. The electric field strength E can be estimated from the Gauss law using the assumption $r = \lambda_{em,e}$.

   $$eE = \frac{Ne^2}{x\lambda_{em,e}^2} = \frac{e^2}{Nx\lambda_e^2} \times (\frac{\beta_0}{4\pi\alpha})^2 \ .$$

3. From an estimate for E can estimate N and from this the area of the flux tube as $S = x\pi\lambda_{em,e}^2$. The area scales like $1/\beta_0^2$. The area, which corresponds to the electric flux of single electron is

   $$S_e = \frac{x\pi\lambda_{em,e}^2}{N} = N \times (\frac{4\pi\alpha}{\beta_0})^2 \times x\pi\lambda_e^2 \ .$$

   For $\lambda_{em,e} = a_0$, one has $S = x\pi N^2 a_0^2$ and $S_e = x\pi N a_0^2$. S_e increases with E so that the density of electrons decreases.

4. At the larger electrode E is weaker and the number of flux tubes is by a factor M larger. M is in a reasonable approximation the ratio E_{small}/E_{large} of the electric fluxes.

3.4 Charge asymmetry and quantum coherence

The following argument allows us to understand the charge asymmetry in terms of a smaller quantum coherence at the larger electrode.

1. There are two cases depending on whether a) the smaller or b) the larger electrode is negatively charged. The electric flux $Q = Ne$ of a single flux tube at the smaller electrode must decompose to $M = E_{small}/E_{large}$ flux tubes at the larger electrode.

2. Quantum coherence is possible only at the level of a single flux tube. In the ideal situation quantum coherence at the smaller electrode corresponds to a single flux tube. At the larger electrode the flux tubes of the smaller electrode decomposes to M flux tubes.

3. The rate for the transfer of free electron momentum is proportional to the square of total number N^2 of electrons at a given flux tube at the smaller electrode. In absences of cohere it would be proportional to N.

   At the large negatively charged electrode the flux tube emerging from the smaller electrode decomposes to $M = E_{small}/E_{large}$ flux tubes and the rate is proportional to sum over them giving $M \times (N/M)^2 = N^2/M$. Therefore the effect is stronger when the smaller electrode is negatively charged.

   If the negatively charged electrode is the smaller one, the electric field strength and electrostatic energy decrease faster and the acceleration of the cm is stronger.

The reduction of the electric field strength implies the decrease of $h_{em,e}$ in the process. The reduction of the electrostatic energy makes it possible to kick electrons to the electric body. In biocatalysis the reduction of h_{eff} is proposed to bring reactants together and to kick them over the potential wall. The reduction process of h_{eff} takes place as steps so that also the strength of the electric field should be reduced in steps. Is it possible to detect this?

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