Could the "impossible" EM drive be possible in TGD Universe?

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Abstract

According to Wikipedia article, Roger Shawyer, who is behind the concept of EM drive, has claimed that the prototype produces a total thrust about .02 Newtons using the power by 850 W magnetron. The device could operate only few dozen seconds after the magnetron failed due to overheating.

There would be no fuel in the conventional sense of the word. Basic conservation laws of momentum and energy however require that if system gains momentum there must be another system gaining opposite momentum. For ordinary rocket this would be exhaust fuel. No exhaust has been observed and this is thought to make the drive "impossible". Also energy is needed. The magnetron would provide this energy.

The working principle of EM drive is abstraction of ordinary rocket principle. Fuel is replaced by microwave energy leaking out from the system in non-symmetric manner so that momentum leakage takes place and gives rise to a recoil forcing the rocket to move. As such it it not anything impossible. The question is whether the energy and momentum really leave the system. The failure of magnetron suggests that at least some fraction returns to magnetron somehow and heats it. Magnetron is a school example of a critical system and in TGD framework this would suggest phase transition producing dark photons with $h_{eff} = n \times h$ at the flux tubes of its magnetic body (MB) with much higher energies than ordinary microwave photons. If the dark microwave photons leaving microwave cavity go to the magnetic flux tubes they could return back to magnetorn and transform to ordinary high energy photons and heat the magnetron and also bring the momentum back to the system. This might mean severe problems.

Contents

1 Introduction

NASA's impossible EM drive has appeared in Facebook again and again (see http://tinyurl.com/hq7vd3a as an example), and I finally lost my patience and decided to learn what it is involved. The Wikipedia article (see http://tinyurl.com/zkwoehe) describes the EM drive and gives a lot of references. The original skepticism by mainstream is probably changing to a real curiosity after several replications.

First some raw data from the Wikipedia article.

1. According to Wikipedia article, Roger Shawyer, who is behind the concept of EM drive, has claimed that the prototype produces a total thrust about .02 Newtons using the power by 850 W magnetron. To get some perspective note that in order to move 1 kg weight with the velocity of 1 m/s in the gravitational field g= 10 m/s^2, a power of 10 W is required so that the construction might be scalable. The device could operate only few dozen seconds after the magnetron failed due to overheating. Therefore the hypes abut travels to Moon within few hours should be taken cautiously!

2. There would be no fuel in the conventional sense of the word. Basic conservation laws of momentum and energy however require that if system gains momentum there must be another system gaining opposite momentum. For ordinary rocket this would be exhaust fuel. No exhaust has been observed and this is thought to make the drive "impossible". For instance, NASA researchers talk about "quantum vacuum virtual plasma" as the system with which the momentum would be exchanged. Also energy is needed. The magnetron would provide this energy.

The theory of Shawyer for EM drive can be found at `http://tinyurl.com/zkwoehe`. The basic idea is very simple.

1. Consider first an ordinary rocket. The fuel explodes and liberates chemical energy and part of exhaust products are allowed to leave the rocket, which experiences the reaction force and gains momentum. One can also modify this rocket a little bit. This is not practical but serves a noble pedagogical purpose. Allow the fuel leak out in opposite directions but in such a manner that the leakage is smaller in the second direction. Rocket accelerates also now since the two forces due to the leakage do not cancel each other.

2. Next do some abstraction. What matters are conservation laws are energy and momentum, not the medium which carries them. Replace fuel with microwaves in a microwave cavity reflecting forth and back and having energy but no net momentum. Replace the fuel tank by magnetron producing the radiation.

   Arrange the situation so that the leakage of momentum is realized as radiation pressure, which is different at the ends of cavity. For the ordinary fuel this is not a problem and it is difficult to see why it should be so for em fuel. This em fuel would be produced by magnetron in cyclotron transitions with cyclotron transition frequencies equal to resonance frequencies of the microwave cavity. This requres tuning of of the strengths of magnetic field and length of cavity. System would be critical in this sense.

3. The asymmetry between ends realized somehow would create a net force on the system as difference of the forces at the ends of the cavity. One could interpret this also by saying that the reaction force forces the system to move. The needed momentum exchange would be between radiation field and rocket. Microwave energy and also a net momentum leaves the system just like momentum carrying fuel from ordinary rocket. The dimensionless Q value characterized the flow of energy out of the system. Also the flow of momentum at the ends of the cavity would be proportional to Q.

4. The claim of Shawyer (see `http://tinyurl.com/zkwoehe`) indeed is that the net forces (pressure times area) at the two ends are different. This would be due to the different group velocities assignable to classical em field at the two ends of the cavity and also due to different area. The argument is that at the smaller end (disk) the group velocity of wave is lower due to the fact that the reflections from the walls of the cavity occur more often so that paths of photons become more zigzagged and the net propagation for energy becomes slower. This argument makes sense to me. Of course, to really understand whether this is the case, would require a detailed modelling of the situation.

2 The problem and its solution in TGD Universe

What is then the problem?

1. It is argued that the construction breaks momentum conservation. If microwave photons leak out they should heat the cavity and the energy and momentum would leak out as thermal radiation. Is it that this radiation is not observed or is the heating theoretically so small that it cannot be observed? There is however the heating of magnetron, which forces to stop the experiment. As if the energy and momentum would go to the magnetron! Could this microwave energy be enough to achieve the heating of magnetron? Microwaves are indeed used for heating and they might be able to do this. But how the leaking energy and momentum could end up back to the magnetron?

2. Recall that in the experiments of Russian physicists in which magnetic motor was claimed to start spontaneously acccelerate in in its rotational motion similar breakdown was the problem [K1]. Similar breakdown plagues also Yildiz motor [K1]. I have proposed for both systems a TGD based model involving the MB of the motor and dark photons and particles. What could cause this breakdown? Could it be that energy and momentum that should have left the system is actually feeded to the magnetron via its MB consisting of flux tubes serving as channels?

2.1 Magnetron

To understand what might be involved consider what magnetron is (see `http://tinyurl.com/cmlg9gf`).

1. Magnetron produces the microwave radiation and serves obviously as the energy producer. The operation principle of magnetron is as follows. One has two electrodes - the negatively charged cathode and the positively charged anode - at the opposite ends of a cavity (not the microwave cavity) with some length L. Constant electric field is generated between elecrodes. Electrons flow from cathode to anode in this electric field. One adds a magnetic field orthogonal to the plane of the motion for electrons. This fields forces electrons orbits to curve in the plane orthogonal to the magnetic field.

2. There is a critical value of magnetic field for which electrons just reach the anode. For stronger magnetic field they turn backwards before reaching the anode. Magnetron operates using this critical field. Note that resonance condition defines second criticality condition. Cyclotron photons created in magnetron have frequency, which corresponds to a resonance frequency $f = nc/L$ ($c = 1$ in the sequel) of the cavity and standard quantum theory tells that their energy is given by $E = hf$. This is very small energy and it is not at all clear whether photons with this energy can cause heating of the magnetron.

2.2 Notions of dark matter and magnetic body

Next the TGD view about dark matter is needed [K3, K8, K5, K4].

1. Dark matter, also dark photons, has non-standard value of Planck constant $h_{eff} = n \times h$ is generated in TGD Universe in quantum critical systems, which can appear in all scales. The process can be regarded as a quantum phase transition. One experimental motivation for the hierarchy of Planck constants were the strange quantal looking effects radiation in EEG range (ELF) on vertebrate brain. The eplanation was in terms of dark $h_{eff} = n \times h$ cyclotron photons. Dark cyclotron photons have energies and therefore also momenta much larger than they should have by $E = h \times f \rightarrow = n \times h \times f$.

2. These dark photons can transform to ordinary photons and vice versa but do not appear in the same interaction vertices with particles with different value of h_{eff} - hence darkness for practical purposes. Biophotons would be example of ordinary photons produced from dark photons in this phase transition like process.

3. The associated notion is magnetic body (MB) consisting of flux tubes and flux sheets and carrying these dark protons. MB can be identified as intentional agent in biosystems and receives sensory input from biological body as dark photon signals and controls it by dark photon signals.

2.2.1 Is magnetron a quantum critical system generating dark cyclotron photons?

Could it be that magnetron is quantum critical system and generates dark cyclotron photons with large value of Planck constant?

1. Could the criticality of magnetron imply that part of the cyclotron photons created by the magnetron are actually dark and have much larger energies and momenta than ordinary photons. Could the MB of magnetron be in contact with the second microwave cavity and could the dark cyclotron photons leaking from the ends of the cavity end up to MB and from MB back to magnetron and heat it?

2. The system is claimed to not produce any visible exhaust products - that is ordinary microwave photons. Could the leaking exhaust product be dark microwave photons and thus not visible and having very large energies? Could the dark photon exhaust products end up to the magnetron by the above mechanism. Here they would partially transform to ordinary high energy photons and heat the cyclotron inducing the failure of its operation.

3. Magnetron produces high energy dark photons, maybe with energies in visible range if the model for biosystems is taken as starting point. One can argue that the description in terms of classical fields gives a realistic estimate for the total power irrespective of the value of h_{eff}. Thus the net power would not matter. Microwaves have extremely tiny energies (for 1 meter wavelength a fraction about 10^{-6} about the energy 1 eV photon, which is just below the visible range). The dark photons transformed to say ordinary high energy photons with energy of visible photons would interact with the condensed matter by inducing molecular transitions and the heating effect could be much more effective than for ordinary microwave photons. Thus one would have the primary heating of magnetron plus the heating caused by the dark photons from the microwave cavity.

4. Any owner of microwave oven can however argue that microwaves are very efficient heaters. Why dark photons would be needed? Now I cannot silence the heretic inside me. Do we really know what is happening inside our own microwave ovens? Could also this microwave heating involve dark photons with energies, which correspond to molecular transition energies? Could this be the reason for the unreasonable effectiveness of microwave ovens? Microwave ovens involve also another strange phenomenon - small but visible ball lightnings [K7]. Could the visible and UV photons resulting from dark microwave photons heat the air to form a plasma producing the visible radiation? Microwave radiation can also induce "burning" of water involving flame of visible light [K6]. I have proposed explanations of also these phenomena in terms of dark photons transforming to the analogs of bio-photons with energies in the range of molecular transition energies.

If the microwave energy and also momentum returns back to magnetron as dark microwave photons, the magnetron would receive - not only part of the energy - and also part of the momentum opposite to that obtained by the system minus magnetron. If all momentum returns to magnetron, the recoil momentum would not actually leave the system: space-flight might not succeed!

2.3 TGD view about the standing waves in wave guide

It has been proposed that the paired photons with sum of electromagnetic fields equal to zero in microwave guide should make possible the leakage of the radiation (see `http://tinyurl.com/z5quluy`. I find it difficult to make sense of this argument. This article however inspired to look the situation using TGD based view about em fields.

In photon picture photons would be reflected from the ends of the cavity and also from the side walls if the cavity is a cone cut from its ends. In reflection energy is conserved by a momentum which is twice the projection of momentum in orthogonal direction is lost. If the net losses occurring at opposite ends are different, thrust results, even if Q value is vanishing. Only in special case the wave vectors are quantized the net momentum current at the ends of cavity vanishes (discrete translational symmetry). These situations correspond classically standing waves.

In Maxwellian theory em fields should correspond to standing waves with opposite wave vectors. Standing waves in TGD framework are not possible at single space-time sheet. Maxwellian

linear superposition fails. The basic solutions are "massless extremals" describing propagation of arbitrary pulses in single direction, left or right, with maximal signal velocity preserving pulse shape [K2, K9]. Linear superposition for the pulses travelling in the same direction makes sense. This represents precisely targeted communication.

How to obtain something analogous to standing waves in TGD?

1. One can have two parallel space-time sheets in which the propagations occur in opposite directions. Tests particle (small 3-surface) touching both sheets experiences the sum of forces created by the classical fields, and this corresponds to that created by a standing wave. More generally, one can have set theoretic unions of MEs and these effective represent linear superposition of waves (actually only of their effects). This is the manner how many-sheeted space-time give rise to the space-time of standard model and GRT.

2. Suppose the cross section fo wave guide is constant. If only standing waves, that is pairs of MEs carrying momentum of same magnitude, are present, they can disappear from the wave guide only in pairs. The net value of lost momentum vanishes for each lost ME pair and it would seem that one cannot have asymmetry in the case of a wave guide with a constant cross section.

3. If the members of ME pairs have different wave vector components along wave guide the loss of ME pair means a net momentum loss. Could the reflections of MEs at the ends and walls be such that the magnitude of the momentum component in the normal direction not only changes sign but is also reduced so that also energy of photon is reduced. This could be the counterpart for the non-vanishing Q-value.

   The first ME would correspond so a sum of pulse, 2 times reflected reflected pulse, 4 times reflected pulse, etc... The second ME would correspond to sum of $2n+1$ reflected pulses and loss of ME pair would mean a net loss of momentum but it could go the walls of the cavity.

4. In cylindrical geometry the condition that one has standing waves implies $k = n2\pi/L$ so that the value of n would change in the reflection which would be like quantum transition. The lost 4-momentum would be $\Delta p_4 = (\Delta p, 2\Delta p) = \epsilon(p, 2p)$, $\epsilon < 1$ and tachyonic. This momentum could go to the wall of the microwave cavity as a whole. One can also imagine that only part of momentum is lost in this manner and that the momentum splits to part $p_1 = \epsilon(p, p)$ leaking out as dark photon and $p_2 = \epsilon(0, p)$ absorbed by the wall of cavity. This contribution would correspond to radiation pressure. Also more general momentum splittings are possible.

5. Could the lost photon with 4-momentum $\epsilon(k, k)$ go to a magnetic flux tube of magnetron as dark photon? In the general case light-like momentum $\epsilon(k, k)$ should be parallel to the flux tube and the the rest of momentum difference Δp_4 would go to the wall of cavity. If flux tube of the magnetic field of magnetron is parallel to the wall of the cavity, this is not possible. If the flux tubes are parallel to the ends of the cavity, they should absorb the entire Δp_4. This suggests that flux tubes should be nearly orthogonal to either end of the wave guide.

Armed with this picture one can try to answer the question whether one obtain net acceleration lasting the desired time.

1. Whether one can obtain a net momentum transfer to the MB of the system, depends both the shape of cavity and on the direction distribution of flux tubes and their density at surfaces orthogonal to the average magnetic field. This density is proportional to the average magnetic field. The magnetic field of magnetron is dipole field in the first approximation and the flux tubes form closed loops.

   A good position for the wave guide is such that magnetic field lines meet the second end of the wave-guide nearly orthogonally. The magnetron could be from left or right from the wave guide, maybe nearer to the end with larger area to maximize the number of flux tubes meeting the end. One would obtain dark photons at the magnetic flux tubes leading to the magnetron and - if not else - at least an explanation for why magnetron heats up so fast!

2. Is it really possible to obtain accelerated motion in long time scale? Dark photons would go to states analogous to angular momentum eigenstates since the flux tubes are closed where as the net momentum would go to the cm motion of the flux tube pushing it farther away. System plus its MB does not accelerate unless MB is able to transfer its momentum somewhere, say to a larger MB. This probably poses limits on the distance which the system can move since one naively expects that system and its MB tend to move in opposite directions so that MB would stretch. One expects, that MB can store only a limited amount of momentum to say Bose-Einstein condensate of dark photons.

   The momentum transfer (as dark photons) to a larger MB would require reconnections with it. Reconnection is a standard mechanism in TGD based quantum biology [K6] relying strongly on the dynamics ("motor actions") of MB (braiding making possible topological quantum computation, reconnection making possible dynamical flux tube networks, h_{eff} changing phase transitions changing the length and the thickness of flux tubes as scales proportional to h_{eff},..).

What criticisms and other variants of the general idea - exchange of momentum with MB - one can consider?

1. The model of authors proposes that the classical em waves/photons are reflected from the walls of em-drives and in this process the longitudinal momentum is reduced in the direction in which the cavity gets narrower. This is an attractive idea intuitively.

   As the photon is reflected from the wall of the cavity it loses momentum and some energy. Modes are quantized by boundary conditions and the energy of mode decreases slightly. Where does the lost energy go? Since the change of energy is small and change of momentum large, the energy must go to energy of some massive particle with mass M: $\Delta E = (2k_N)^2/2M = 2(k_N/M)k_N$ so that the fraction of energy lost is smaller than $2(k/M)$ and very small. Lattice oscillations are a natural identification. The energy would be transformed to heat.

2. If part of the photons leak out at walls and ends of the cavity as dark photons the magnetic flux tubes, a net force is generated. If the magnetic field of cyclotron is vertical it can be parallel to em drive only in regions where the direction of flu tubes becomes horizontal. This might be a real problem.

   (a) Cavity could have its own dark magnetic body with dipole axis naturally parallel to the cavity. Also the electrons in magnetron turning around could send part of cyclotron photons as dark photons to the flux tubes of dark MB parallel to magnetron.

   (b) Suppose that MB - whatever it is - carries dark matter. In TGD inspired quantum biology MBs have the role of intentional agent and MB is able to self-organize in optimal shape to control the biosystem. In particular, MB soaks up metabolic energy from biological body. One can speak of symbiosis.

   Could a primitive living system form also now in such a manner that the MB of magnetron organizes in such a manner that flux tubes become parallel to the cavity at its ends? The metabolic energy could come from magnetron, which in turn could get its energy from surrounding space by some technology (the point is that no fuel is needed). In the model of rotating magnetic systems [**?**] a self-organization of the flux tubes of the magnetic field generated by the magnetic system to dark magnetic flux walls is indeed assumed. The MB formed in this manner would soak up metabolic energy from the em drive.

   (c) Could the magnetic field $B_E = .5$ Gauss of Earth or the endogenous dark magnetic field $B_{end} = 2B_E/5$ playing a key role in TGD inspired quantum model of biology be involved [**?**]? If the direction of B_{end} is that of B_E, the functioning of em drive depends on the orientation of the em drive unless the flux tubes of B_{end} self-organize so that they are parallel to the cavity symmetry axis.

   (d) Also the flux tubes of the magnetic field - call in B_{gal} having strength of order 1 nT assigned to the intergalactic magnetic field are proposed to be fundamental for living matter: the corresponding cyclotron frequencies for ions would correspond to biorhythms

longer than those of EEG up to circadian rhythm [**?**]. Could the flux tubes of B_{gal} self-organize themselves parallel to the cavity?

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